Introduction to Challenge

Join NASA and its flight engineers in this unique design challenge. Learn how to apply theoretical knowledge with design limitations to produce a working glider model. Experience the team planning and design challenges needed to carry through a design concept to a successful demonstration in the world of aeronautical engineering.

In-Class Research-Design Activities

RISKING FAILURE TO BE SUCCESSFUL
CHASE THE PROBLEM
TO MEET THE CHALLENGE
TO FLY THE DREAM

Here is your Challenge:

Produce a design that incorporates a shoebox as part of your glider. Additionally your Shoebox Glider will have to meet the criteria and constraints partially listed below. Your Challenge is open-ended and involves a variety of collaborative and creative problem solving efforts!

As part of your challenge, you will need to accomplish the following tasks:

- Research the dynamics of flight and apply them to your efforts.
- Determine and gather the materials you will need for your glider.
- Determine how to launch the shoebox glider in a consistent way.
- Obtain the most efficient glide slope ratio possible.
- Demonstrate your understanding and success to NASA

Guidelines

1. Write the words “criteria and constraints” on the board. Ask students to define the terms. Explain that when designing any device, the inventor-engineer must consider criteria and constraints.
   *The students should understand that **criteria** are standards or requirements that the device must include. Examples of criteria are that the device must be efficient, must be able to land gently, and must be able to glide a certain distance.*
   ***Constraints** are things that limit the design of the glider. Examples of constraints are money, time, maximum size, available materials, space to build or fly, and human capabilities.*

2. Under the title: “Shoebox Glider Criteria” write the following:

  a. The glider must move forward for at least 3 meters.
  b. The glider must demonstrate an efficient positive glide slope ratio.
  c. The glider must not break upon landing.
  d. The glider's glide slope and aspect ratios must be determined.
  e. Teams will prepare a final presentation of results and understanding.

3. Under the title: "Shoebox Glider Constraints" write the following:
  a. The glider must include an intact shoebox in its design.
  b. There are no material constraints.
  c. There will be a working-researching-testing time limit set by the classroom teacher.
  d. Final team presentations will be limited by time, depending on the number of total presentations. Usually 5 to 6 minutes.

4. Using provided and any additional resources students can begin background research, gathering materials, designing, and construction.

Peer Evaluations

1. After student teams have completed their research and designs, have different groups switch design plans and evaluate each other's proposals.
2. In this evaluation process, the groups should focus on whether the design meets the criteria and constraints up to this point and to offer any constructive criticisms or suggestions that would lead to greater success.
3. Once the groups have shared their evaluations, discuss as a class what the students learned from this peer evaluation. Lead a discussion using the following questions:
  a. Did your glider design meet the criteria and constraints?
  b. What changes would you make and why?
  c. What helpful comments did you get from the other group?
4. Explain to the students that an important part of the design process is revising the designs prior and during flight-testing.

Preparing for Flight Tests

1. After making improvements, the teams should be ready to test their shoebox gliders. *Note to teacher: A large space will be needed where the gliders can be tested. Outside or in your school's gym might be a great place to test them.*
2. Have teams keep records of designs, research, peer evaluations, changes made, what problems they had to solve during the design process and how they solved those problems.
3. Based on the scoring rubric have the students be responsible for gathering and recording the following data: how high the glider was released from (altitude), the distance it covered, calculating glide slope and graphing these results, determining the glider's aspect ratio, and total time aloft.

Flight Testing

1. Explain that the teams are now going to compete against each other to determine which glider is the most efficient in terms of glide slope. A glide slope is a method of making a standardized comparison of each team's efforts regardless of the height a team's glider was released from or the distance it covered. Discuss that there is not a perfect design, but scientists and engineers do look for the design that is the most efficient.

2. Discuss with the students that sometimes tradeoffs have to be made among features (aerodynamics, stress, and weight) in order to make the glider the most efficient. Ask students to identify and record any tradeoffs that they make to their gliders during their flight tests.
3. Have teams run as many flight tests as possible during the time constraints set by the classroom teacher. The data from the test flights can then be averaged, or the best one used.
4. Have the students compare the data of their original test flight to their later or best flight to monitor improvements in efficiency.
5. As a class, decide which gliders are the most efficient in terms of the glide slope data obtained from their flight tests. Discuss with the students that this does not mean this is the perfect design.

Discussion/Wrap-up

1. Have the students explain the steps they went through to design their shoebox gliders. Ask the students if they think scientists and engineers follow similar steps. After the students have shared their ideas, explain that the students followed a very similar process to that of design engineers.
2. Explain that the basic design process includes: defining a problem, specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or building it, and communicating the process and results to others.

Presentation Content

Student Team Presentations

Student teams are selected to present to NASA's DLN

- Classroom Teachers and the NASA Educational Host can determine which student teams will present their results during the second DLN connection.
- The remaining student teams will be passive participants.
- *The ideal situation is to have all student groups present!*

Student Presentation Requirements

- Each team has 5 to 6 minutes to present the following items and information:
  - The actual experimental Shoebox Glider
  - Visual of its flight (images in sequence, video, MPEG, etc.)
  - Recorded Distance and Height of flight

- Calculated Glide Slope = D/H
- Calculated Aspect Ratio = L/W
- Interpretation of Glide Slope w/ graph of slope
- Interpretation of any relationships between Glide Slope and Aspect Ratios
- Description of problems and successes during design process.

Presentation of Student Solutions

Student Challenge Presentation Videoconference

Student teams with the most efficient glide slope ratios will have the opportunity to make a 5 to 6 minute visual-oral presentation to NASA's Digital Learning Network team of their flight test results, understanding of flight dynamics, and problem solving process.

Presentation of Student Solutions Videoconference Outline

- Introduction to NASA and Host-Panel
- Challenge Objectives
- Team Presentation Requirements
- Timed Team Presentations with Follow up by NASA DLN host
- Closing observations and comments
- Good-bye from NASA DLN